

Are We Providing Effective Mechanical Ventilation in New US Homes?

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What is effective mechanical ventilation?

What MV equipment is required by code?

Does installed MV meet code?

Is MV used routinely?

Why do we need ventilation?

Build tight, ventilate right!

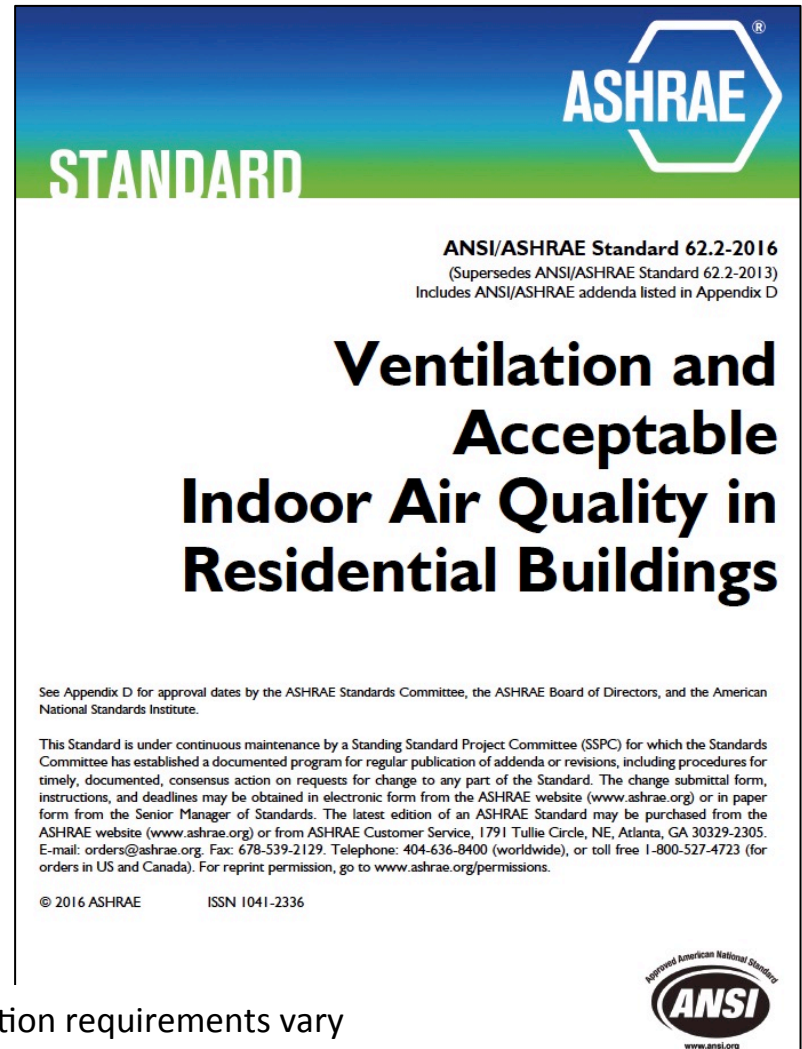
- Reduce exposure to chemical pollutants from materials and products
- Manage bioeffluents, odors and moisture
- Remove contaminants generated with cooking

What is effective MV for a new home?

Use ASHRAE 62.2 as guide*

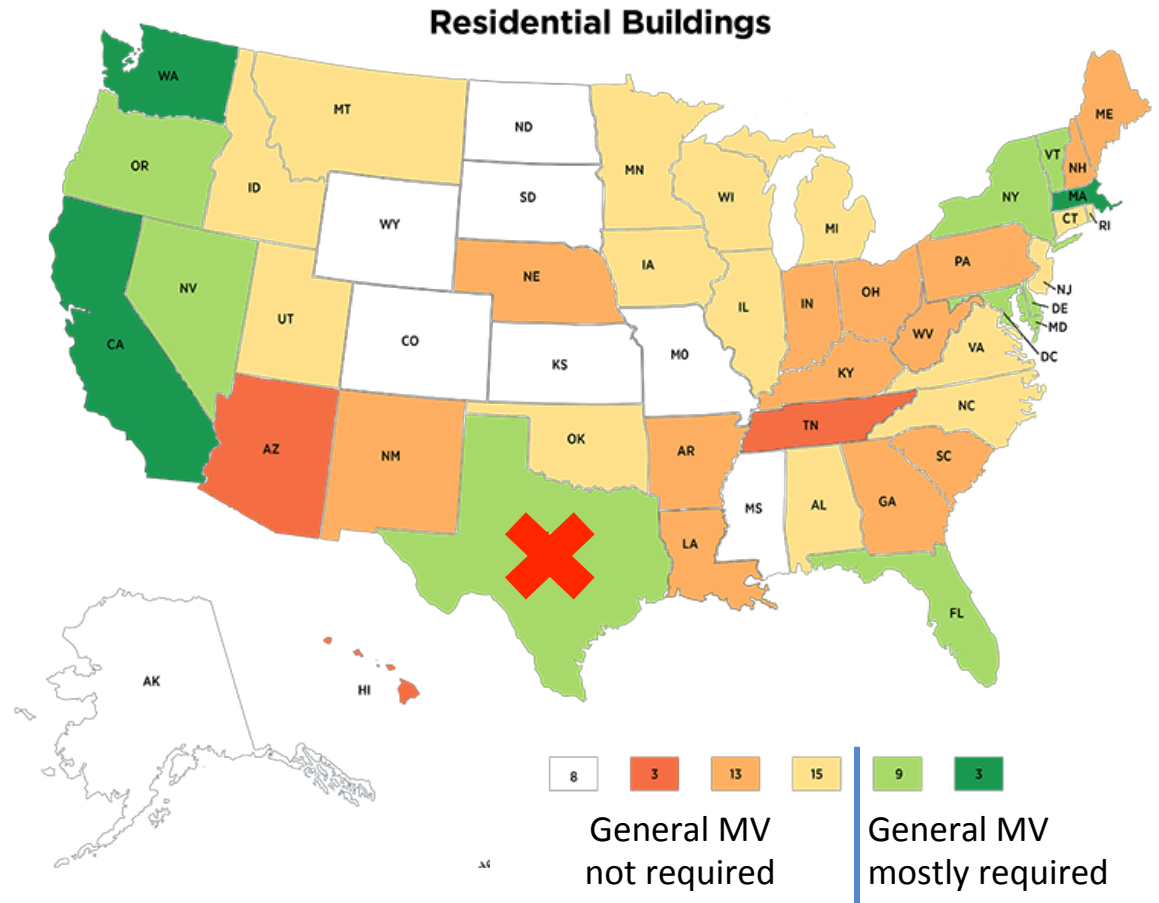
- General ventilation
~0.35/h or more
- Exhaust in every bath & toilet
≥50 cfm (85 m³/h) or
≥20 cfm continuous
- Extract hood over cooktop
≥100 cfm (170 m³/h)
<3 sone

* ASRHAE 62.2 also allows kitchen exhaust fan; general ventilation requirements vary



What is required by code?

- Required in states that adopted IECC 2012 / 2015
- Not required in Texas, some local codes
- Kitchen exhaust required in a few states but not by IECC; use varies by region
- Bath exhaust installed in most new homes



MV required in high performance home programs



80,000 homes
in 2016

816,000 new homes
sold in US in 2016



These programs affect many fewer homes



Checks on MV systems vary by program!



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Does installed MV meet code requirements?

21 Florida homes

MV installed during prior 15 years

Some were pre-code requirement

20 met code requirement of ≤ 5 ach50

3 had airflows close to code-required

2 of those turned off!

Only 12 “capable of operating” as found

(Sonnes et al., 2015)

29 Washington homes

Most built 2008-2012

All ≤ 3.5 ach50; 7 ≤ 1 ach50

As-found, 19 met general MV

Timer adjust -> all but 3 met airflow

Mean: 137% of airflow requirement

Many maintenance & install issues

(Eklund et al., 2014)

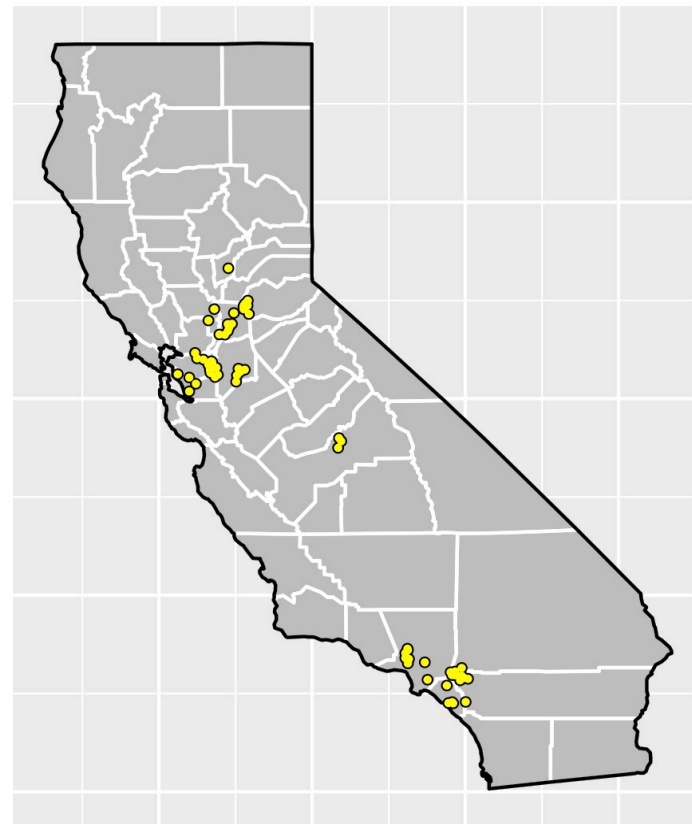
Since 2008, California building code has required MV similar to ASHRAE 62.2

2011 study of 15 new homes (Stratton et al.)

2016-18 study of 70 homes built since 2011

- Characterized equipment, measured flows, observed status
- Monitored IAQ, equipment use for week
- Survey about satisfaction, MV use, other

Paper 542, Chan et al., Wed @13:30



Does installed MV meet code requirements?

15 California new homes, 2011 data

Only 2 met all code requirements

2 had insufficient central MV, 13 OK

2 had recirculating range hoods

7 had insufficient airflow in bathrooms

12 used exhaust fan in laundry room

(Stratton et al., 2012)

Central MV systems in 70 California homes

In most cases, the measured airflow of the exhaust fan exceeded the required whole-dwelling ventilation needs.

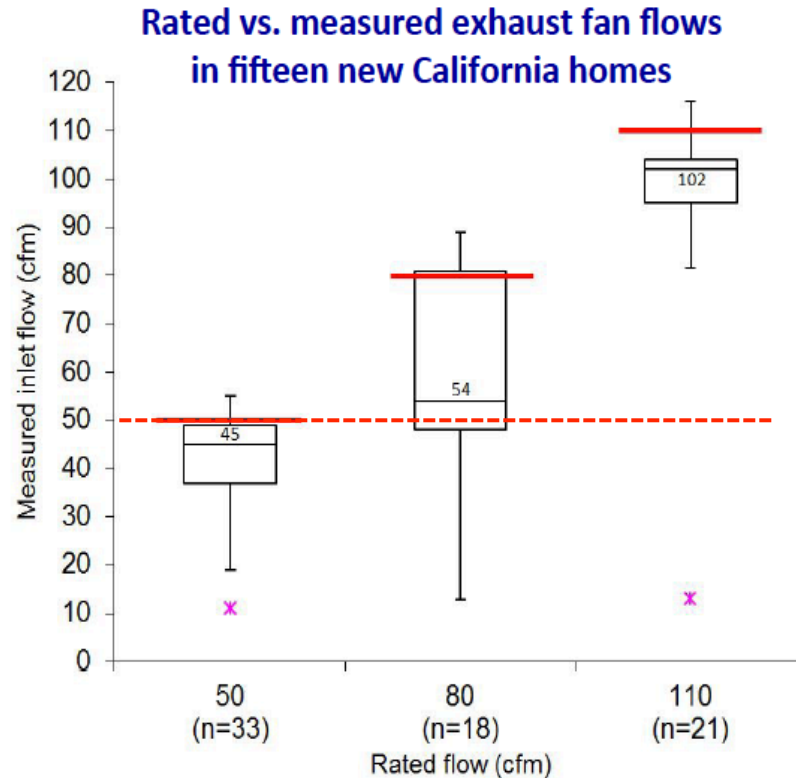
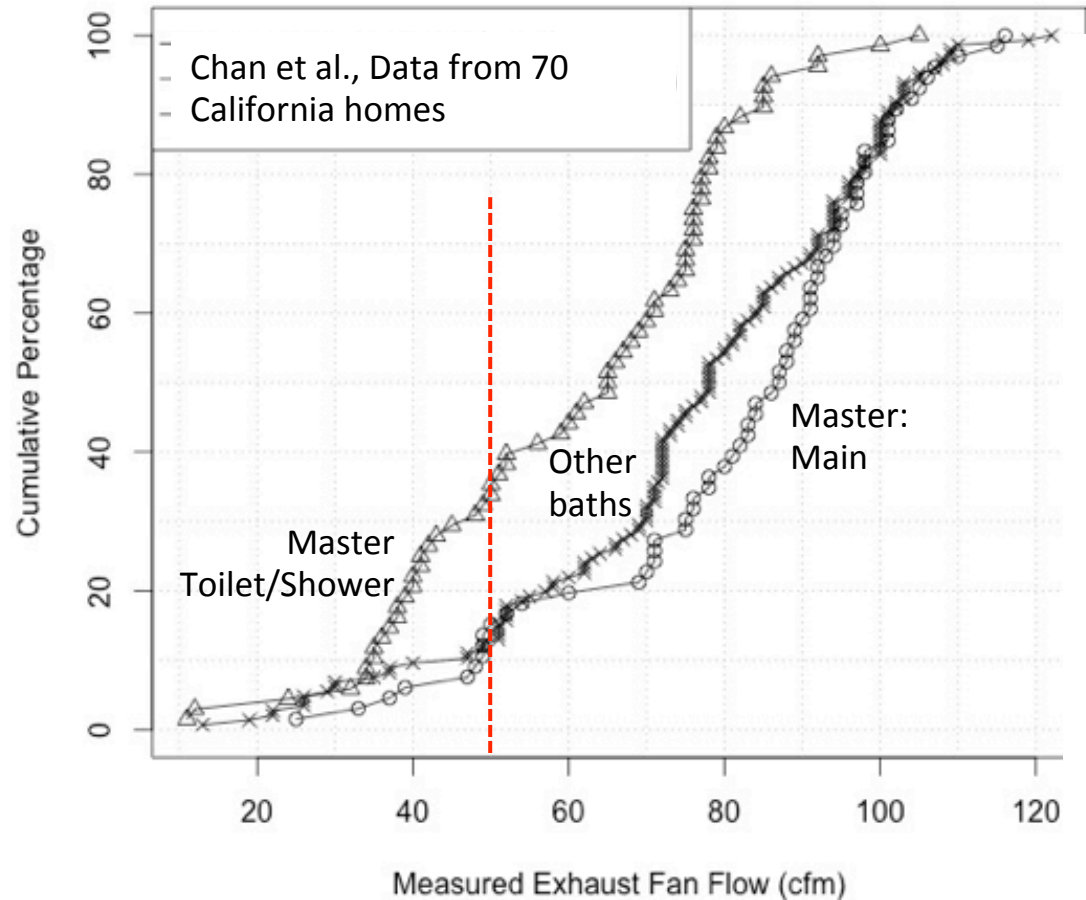
Mean required: 63 cfm
Mean provided: 96 cfm



~50% above code

- Continuous exhaust (N=55)
- Intermittent exhaust (N=9)
- Continuous inline fan connected to central forced air system (N=4)
- Supply ventilation provided by central fan integrated system with a motorized damper (N=2)

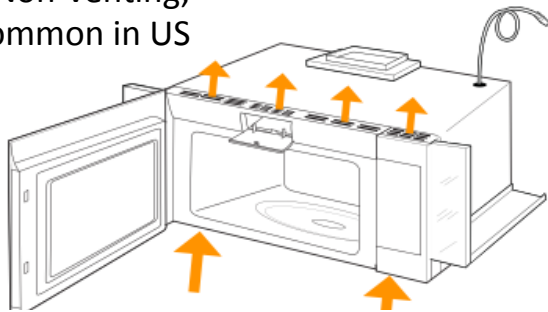
California bathrooms: Most above code, below rated



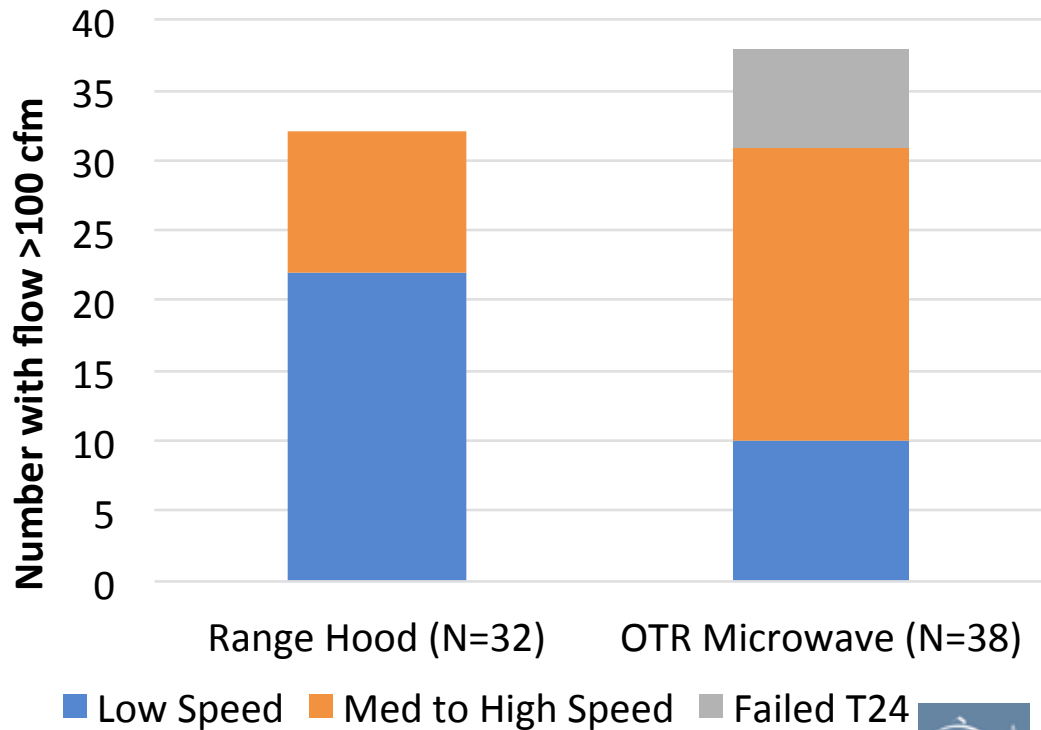
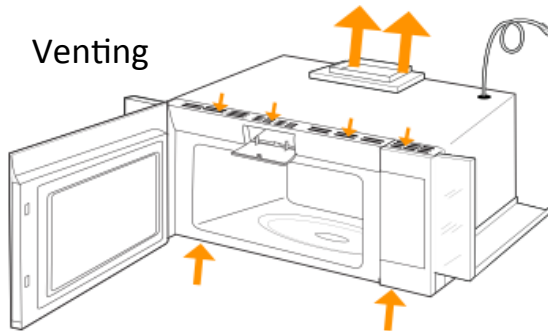
Stratton et al., 2012

Kitchens: Most range hoods meet minimum airflow requirement; but many microwaves don't

Non-venting;
Common in US



Venting



Is mechanical ventilation used routinely?

Are central systems operating?

(What do people know and think about it?)

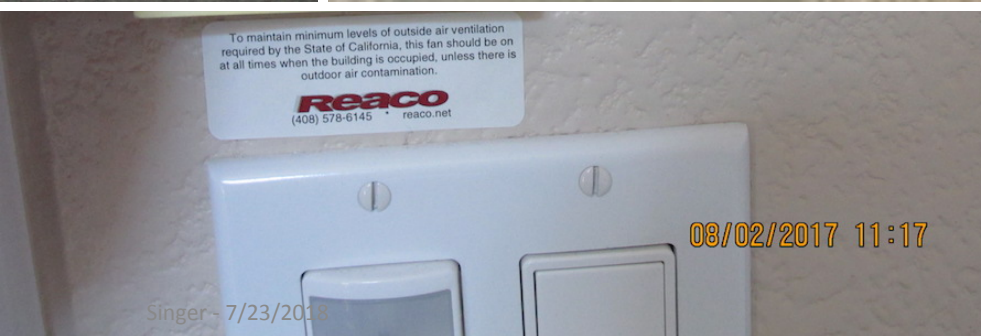
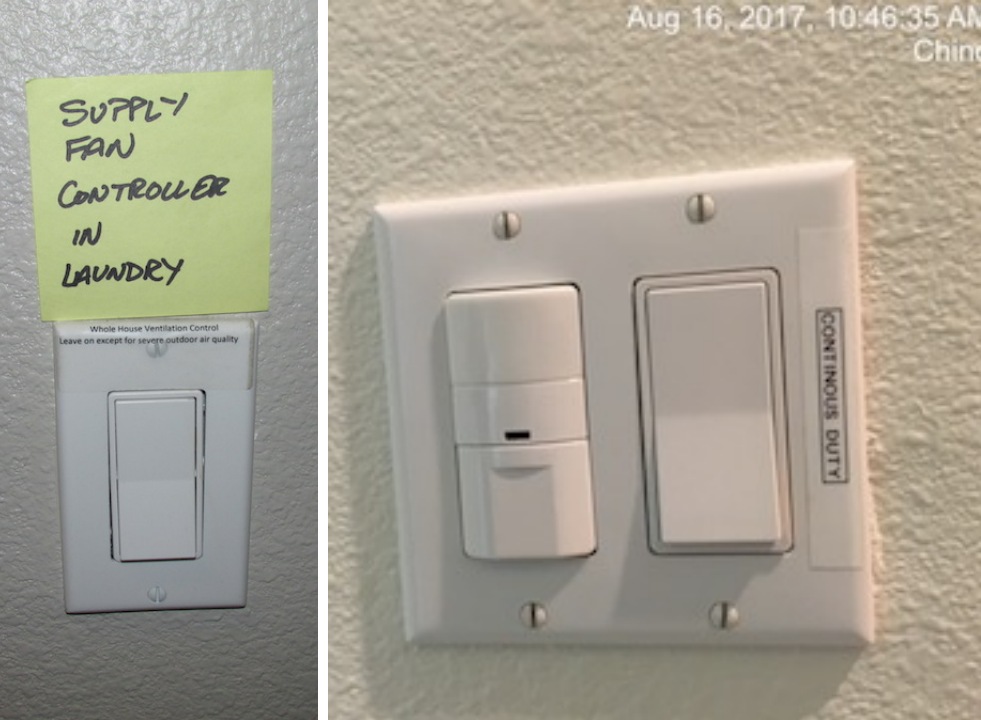
Are kitchen and bath exhaust fans used?

In California, only **1 in 4** homes had the central ventilation system running as found.

Labels matter!

Whole-House Ventilation Control	Controller Labelled?	% On As-Found
On/Off Switch	No (N=42)	5%
	Yes (N=12)	58%
Programmable Controller	No (N=10)	50%
Thermostat	No (N=2)	0%
Breaker Panel	No (N=1)	100%
No Controller	No (N=3)	100%





Labels not always clear

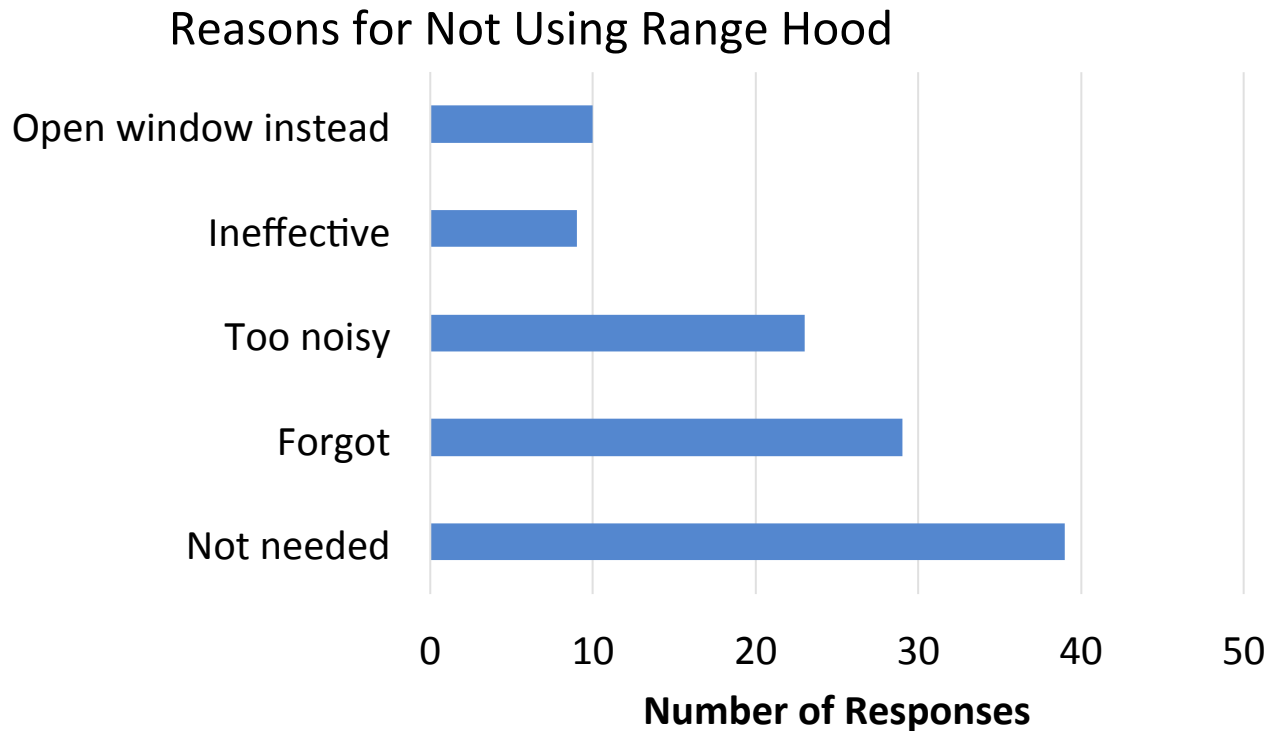
❓ “Continuous Duty”

❓ “Whole House Ventilation Control. Leave on except for severe outdoor air quality.”

❓ “Keep fan **“ON”** at all times except in case of outdoor air contamination or if home is vacant for more than 7 days.”

❓ “To maintain minimum levels of outside air ventilation required by the State of California, this fan should be on at all times when the building is occupied, unless there is outdoor air contamination.”

Half of the CA households reported using range hood sometimes or less frequently



Conclusions

- In states with long-running ventilation requirements, most homes have acceptable equipment installed
- General ventilation systems often turned off even in these states
- Clear labels on switches appears to increase use
- Most homes have adequate bath exhaust fans
- Over the range microwaves common; often not-vented
- Many microwave exhaust fans don't meet code for airflow
- Range hoods meet flow but may be too loud
- Few microwaves meet sound requirement

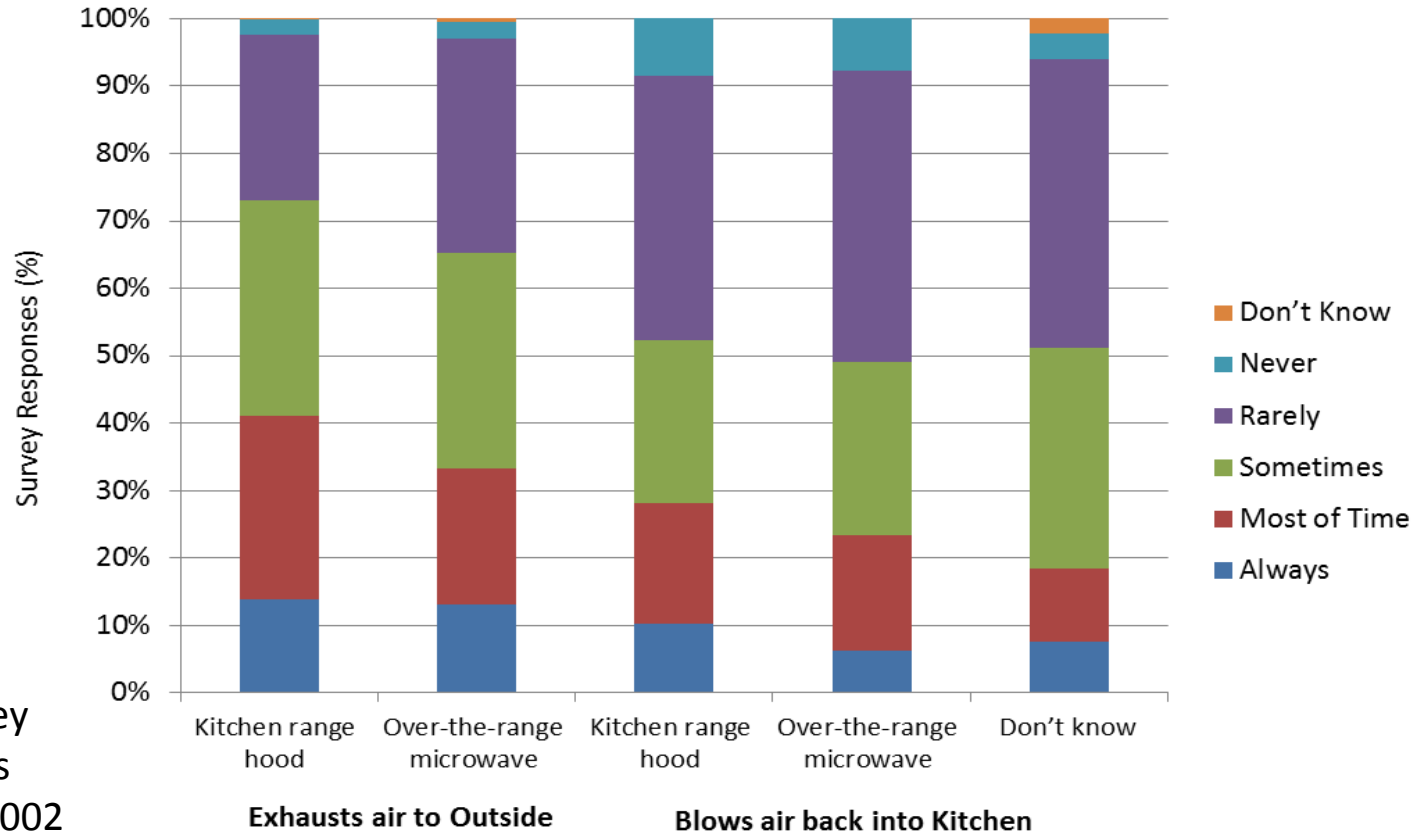


Resources

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- Sonne JK et al. Investigation of the Effectiveness and Failure Rates of Whole-House Mechanical Ventilation Systems in Florida. FSEC-CR-2002-15. June 2015.
- Stratton et al. 2012. *Measuring Residential Ventilation System Airflows: Part 2 - Field Evaluation of Airflow Meter Devices and System Flow Verification*. Report LBNL-5982E. Berkeley, CA: Lawrence Berkeley National Lab.

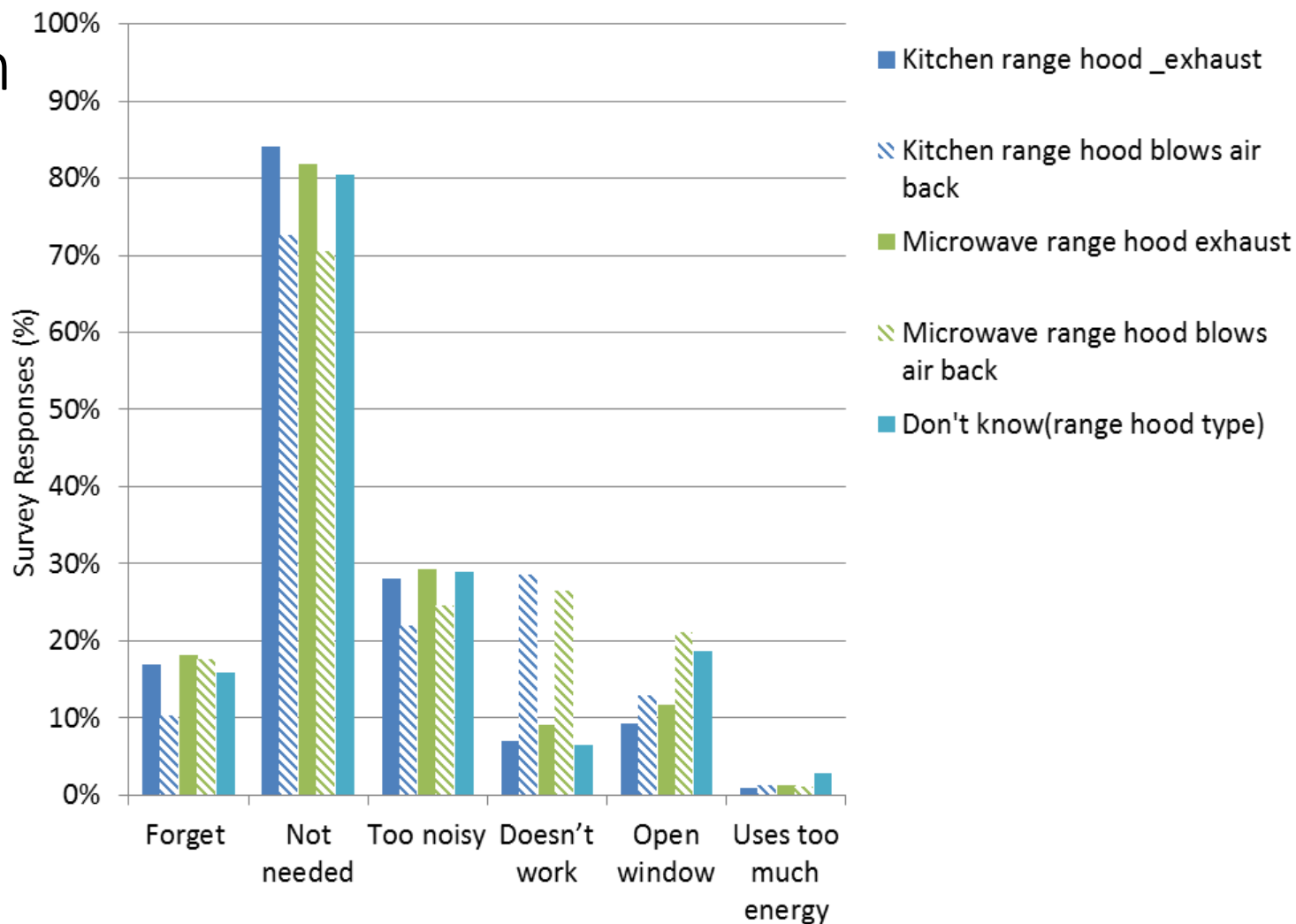
EXTRA SLIDES

Differences in perception - hood vs. microwave, vented vs. non-vented



Perception of vented vs. non-vented

Online survey of CA homes built since 2002



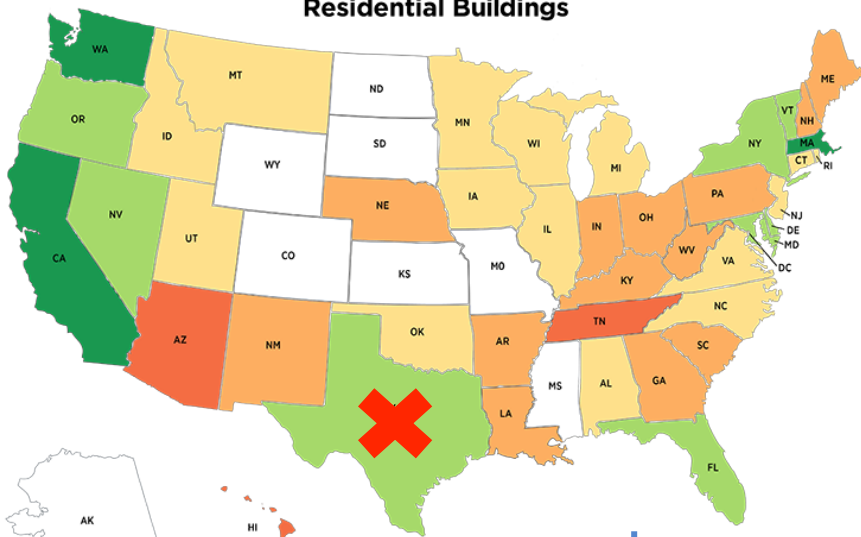
Florida non-operational homes

Finally nine (43%) of the 21 study homes were determined to not be operational. Not operational designations were given for the following reasons:

- Houses 1 and 11: unable to test due to controller failure
- House 4: one of two ventilation systems inoperable due to failure of damper to open
- House 8: a runtime ventilation system with control was shown on the energy rating, but no ventilation system was present at house (only standard bath fans controlled by simple on/off switch)
- Houses 12 and 20: ERV removed (house 12) or ERV ducts disconnected (house 20) by homeowner
- House 13: both ERV units had 120v service and breakers were on, but were not functional; the filters and cores were so clean they may have never operated (the owners were unaware of these units and indicated that they had not changed filters)
- Houses 15: inoperable as intended; ventilation only occurs when air handler is on (damper controllable, but not air handler)
- Houses 16: inoperable as intended; ventilation only occurs when air handler is on, apparently due to incorrect wiring (damper fixed 100% open).

Most homebuilding in South

Residential Buildings

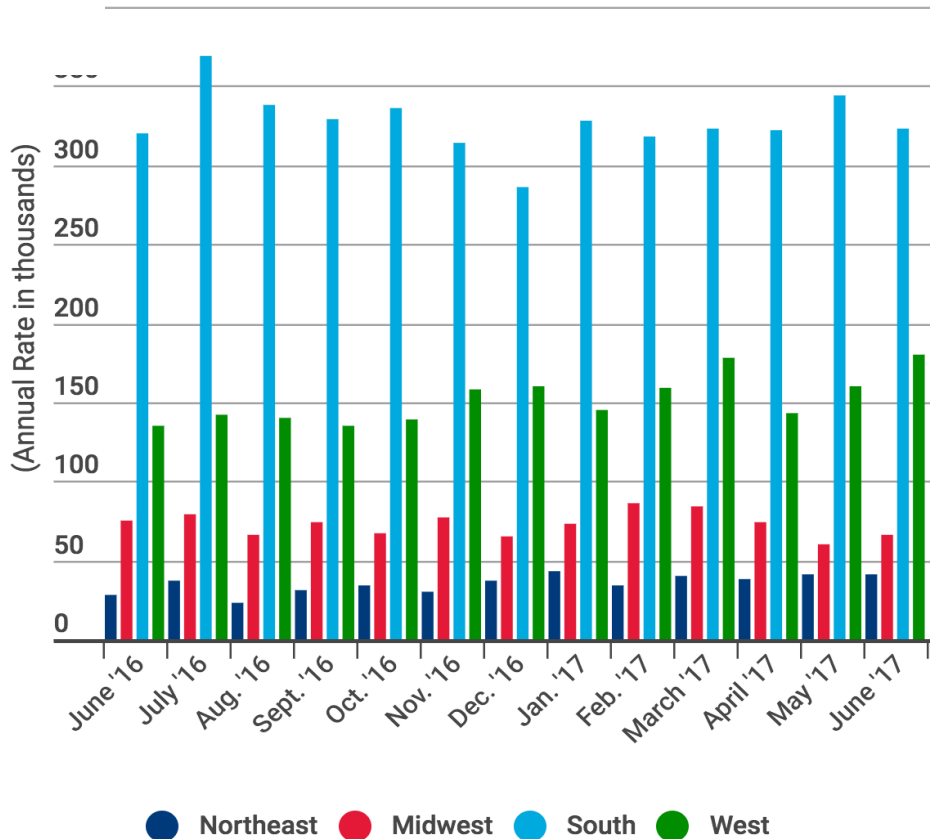


General MV
not required

General MV
mostly required

Singer - 7/23/2018

New Homes Sold



HVAC particle filters in recently built CA homes

- Exhaust ventilation in homes with reasonably tight building envelope
- Medium to high efficiency air filters

MERV Rating	Number of Air Filters (N=112)
6 - 7	4
8	57
10	18
11	22
12	1
13	9
14	1